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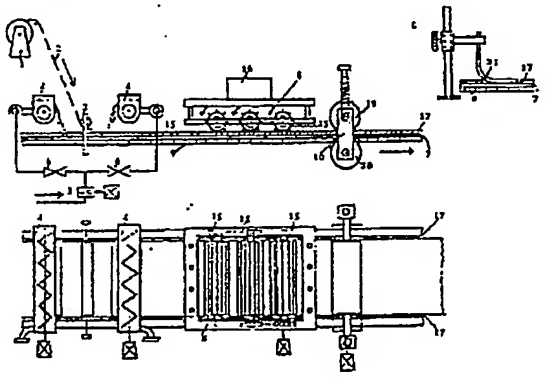
(54) **Process and device for the manufacture of reinforced concrete slabs.**

(57) A process is disclosed for the continuous manufacture of cement articles containing a reinforcement of net-like polymeric structures, which comprises the steps of depositing a layer of water-cement mix on a horizontal porous conveyor belt, depositing an open-mesh, net-like polymeric structure on said layer, depositing a cement layer onto said structure, compacting the thus obtained assembly by vibrations in at least vertical sense, then compressing said assembly to reduce the water content to 25–35% by weight.

A device is also disclosed for performing the process, comprising one or more operational units arranged in series, each one comprising, according to Fig. 1, a feeder 1 for the net-like polymeric structure, an horizontal porous conveyor 7, a device 3 for guiding said structure on said conveyor, at least one feeding-dosing device 4 for the deposition of the cement mix on the conveyor or the net-like structure, a vibrator 8 which vibrates at least in the vertical sense, and a compressor 10.



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DESCRIPTION

of an invention having for a title:

"PROCESS AND DEVICE FOR THE MANUFACTURE OF REINFORCED CONCRETE SLABS."

In the name of : MONTEDISON S.p.A. & MOPLEFAN S.p.A., both Italian Comapnies with head offices in Milan (Italy) - Foro Bonaparte 31.

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The present invention concerns a process and corresponding device for the continuous preparation of slabs, panels and the likes, based on hydraulic or water-settable binders, containing incorporated in them net-shaped structures as a reinforcement.

From Spanish Patent n° 460.292 there are known manufactured articles of cement concrete, also in the form of slabs, containing as a reinforcement layers of oriented, synthetic polymer films, fribrilled and spread open to form sort of a net. Such manufactured articles display a rather high mechanical resistance to bending, pulling, impact, fatigues, to gellification and to permeability to water; wherefore, said articles are considered very interesting for applications in the building field.

The incorporation into the binder of one or more of the net-like structures of the mentioned kind, each formed, in general, by a plurality of superimposed fibrilled polymeric films, hardly leads to a uniform and capillary diffusion of the binder in the net-like structure, there being, above all, the risk of the formation of air bubbles and of portions of the unimpregnated reinforcing structure, especially in a manufacturing process running at industrially competitive output rates.

The process of this invention allows to carry out this preparation in a continuous way, at acceptable industrial production speeds, and without the above mentioned drawbacks, even when using reinforcing structures of a very high number of superimposed layers.

Such a process is characterized in that it comprises at least one full series of the following operations from (a) to (f):

(a) continuous deposition of a layer of a cement mix on a horizontal moving ribbon or band, or a porous surface;

(b) continuous feeding of an open-mesh net-like structure, consisting of one fibrilled film, or of several superimposed fibrilled films, on that layer, in the direction and sense in which moves said porous surface;

(c) deposition of the net-like structure on the surface of said layer;

(d) deposition of a layer of cement concrete (mix) on such a net-like structure;

(e) compacting the whole, consisting of the layers of cement mix and of the net-like structure by means of vibration carried out at least in the vertical sense;

(f) compression of the whole assembly or slab, with the consequential reduction of its content in water to values comprised between 25% and 35% of the weight of the solids present in it.

The process of this invention may consist of one single series of operations from (a) to (f), or it may comprise any wanted number of such operational series, in succession, one after the other, with the formation of slabs containing any wanted number of net-like structures alternated to layers of cement mix.

By "cement mix" one must intend a mixture entirely consisting or mainly consisting of one or more hydraulic or water-settable binders such as e.g.: cement, chalk, mortar and the likes, with water and, in particular the mixtures

having a volumetric ratio water/binder comprised between 30-50/100.

To the mix there may be added different types of additives for various purposes, such as for instance:

- inert materials such as e.g.: quartzy sand, with the purpose of improving the dimensional stability and duration of the finished manufactured article;
- fluidizing chemical agents, known products that in general act in the way to reduce the water requirements of the cement mix or concrete;
- well known chemical agents acting as hardening, accelerating or retarding agents;
- chemical agents well known as water-repellents which act to reduce the absorbtion of water by the hardened cement and improve the performance of the finished slab;
- coloured pigments, to be used in connection with white cement, for the production of coloured slabs;
- water-emulsified synthetic resins that polymerize inside the cement structure, thereby improving the resistance and elasticity characteristics of the finished slab, according to already known techniques;

- short surface-reinforcing fibres, such as: asbestos, cellulose fibres and derivatives therefrom, alkalino-resistant glass fibres, short polyolefine fibres, steel fibres, etc., and in general all the products or materials susceptible to be mixed with the cement.

In fact, a characteristic of the process of this invention is that of allowing, by means of a differential dosing or metering of each layer, the differentiating of the type of mix in the various layers, depending on the particular characteristics one wishes to impart to the slab, with a wide range of possibilities of variation and with the possibility to save in production costs.

For instance, it is possible to use high-resistance cement, which is more expensive, only in the two outer layers, or there may be carried out impermeabilizations with water-repellent agents, or reinforcing treatments with either emulsified synthetic resins or with reinforcing fibres, only in above mentioned layers, with an evident saving on the cost of raw materials. Analogously, the production of coloured slabs may be carried out by using white cement and/or pigments only in the outer layers.

Furthermore, inert fillers may be added only to the innermost layers of the laminate in correspondence with the neutral deformation axis, thereby achieving a saving on the cost of cement and of reinforcement.

The distribution of the flows relating to the deposition of the cement mix layers before and after the deposition of each net-like structure, is made so as to ensure both the complete covering up of the net as well as a uniform presence of the nets in the cement of the intermediate layers.

In the case the slab is prepared using nets of a small number of fibrilled films, which therefore are more easily penetrated by the cement, it is sufficient to have only one dosing or metering device for each net position, unless one desires to obtain slabs of alternate layers of net and cement, in which case at the beginning of the first and of the last series of operations from (a) to (f), there must always be a free metering device or doser forming the initial and the last superficial layers.

The net-like structures, used as reinforcement in the process of this invention, may be of any kind of synthetic polymer capable of forming fibrillable films.

Said net-like structures may be obtained starting from synthetic polymer films, by using known fibrillating methods, capable of imparting to the film by a successive cross-wise spreading an open-mesh net-like structure.

A method suited for preparing such structures is de - scribed, for instance, in English Patent n°1.073.741. The net-like structure used in the process of this invention may consist of either just one single fibrilled film or of a plu rality of superimposed fibrilled films, possibly welded to- gether.

A method of preparation for composite, net-like struc- tures, consisting of a plurality of superimposed fibrilled films and utilizable in the process of this invention, is described, for instance, in Italian Patent n°22.800 A/79, filed in the name of the same Applicant.

The compacting operation (e) is carried out by means of devices that transmit a vibration, in an at least verti- cal sense, to the cement mix and that preferably hit the nets bedded in the cement layers contemporaneously downwards and with a high frequency, without, however, creating points of stopping of the advancing net.

The vertical vibratory action may also be combined

with horizontal vibrations imparted to the surface of the conveyor belt or porous surface.

The compacting operation causes the penetration of the pasty matrix into the net-like reinforcement, acting under pressure against the porous surface, and at the same time bringing about an intimate and uniform contact between matrix and reinforcement, eliminating air bubbles and zones of non-impregnation. The compacting, in general causes a slight loss of water through the porous surface. This water may be allowed to flow freely downward or be gathered, for instance, by means of suction systems with a very slight depression.

Lastly, the compacting may be carried out in combination with vibrating high-frequency movements, imparted to the conveyor belt itself, in the impregnation zones, by electrical or mechanical vibrators, according to known cement vibration techniques.

The compression operation (f) aims at regulating or adjusting the thickness of the slab, at compressing the cement and to eliminate the air as well as the water in excess with respect to the content, considered necessary, of 25-35% by weight on the global weight of nets and cement, and moreover to smoothen its surface.

Before this operation the slab may, however, be subjected to a preliminary dehydration operation by suction under vacuum of the water. Likewise after the compression operation (f), the slab may be subjected to an additional vacuum suction treatment, with the purpose of further reducing the content in water down to the value necessary to confer to it a consistency sufficient for possible successive processing operations such as, for instance, lateral (side) trimming, cutting, undulation,, etc., before the final hardening sets in.

The device, which forms the further object of this invention, is characterized in that it comprises one or more operational units arranged in series, each of which consists:

(a') a net-like open-mesh structure feeder, the structure consisting of one or more superimposed fibrilled films;

(b') a horizontal porous surface in motion;

(c') a device for guiding the net-like structure over the moving porous surface;

(d') at least one feeding-dosing device for the deposition of the cement mix on said surface or on said net-like structure;

(e') at least a vibrator, vibrating in the vertical sense, to be used for compacting the cement mix;

(f') a compressor for compressing the cement mix.

The feeder (a') may be represented by a standard reel-unwinder, reels on which the net-like open-mesh structures are wound up, and works maintaining the tension of said structure low and constant.

The device (c'), acting as a guide for the net-like structure, may consist of a system of either smooth or fluted or grooved rollers, or it may consist of rotating, free-wheeling or motor-driven bushes, and will serve to approach the net-like structure to the horizontal porous surface and/ /or to deposit it onto the layer of cement mix deposited on said horizontal porous surface.

The porous surface (b'), acting as conveyor belt, may consist of a heavy fabric, of the type of paper-mill felts or for cement-asbestos mixes.

Such a surface may have either a levelled or profiled cross-section, with any profile it is wished to impart to the slab, and may moreover, be provided with reliefs, gaskets or side blades, in order to ensure the lateral containment of the cement mixes.

That surface moves in the same direction and sense of the net-like structure feeder.

The feeder-doser (d') must be such as to ensure characteristics of constancy and uniformity of flow of the cement mix on the porous surface and/or on the net-like structure

This device may may consist of various devices of different types, such as for instance:

- a horizontal over-flow (surge) tank fitted with an internal stirrer, in order to avoid the hardening of the mix,, and suitably fed according to the already known techniques, by a volumetric pump;
- a vat provided with a horizontal dosing screw which ensures both the metering by discharg from one side of the vat as well as the advancement of the mix in the vat itself;
- surge pipeline in which, by means of a pump, there is made to circulate a batch of cement mix that is much greaterthan the metered quantity. The dosing or metering, in such a case, is carried out by a volumetric pump which provides to integrate into the circuit the quantity that had flown out of a gauged and adjustable slot placed on the surge pipeline, or through a series of spray-nozzles with gauged bore.

In general, the metering device will have to allow the easy emptying and washing of the installation during the stops of the machine, while it will also have to avoid flow variations due to clogging or to crystalline deposits on the part of the cement.

Each dosing or metering system, moreover, must be fed by a volumetric pump which shall allow to vary the flows from layer to layer, and more particularly the flow of the last layer which, if a good superficial finish of the slab and a sure covering of the net-like reinforcement are wished, must be dosed in quantities much greater than that of the other layers.

The compacting vibrator (e') may take various forms, one of which is represented by element (8) (vertically acting vibrator) illustrated in figure 3, (A) and (B), consisting of a rotating rollers supporting frame (15), the rollers being driven positively and being provided with reliefs, for instance blades arranged radially to the rollers and having a peripheral speed equal to or slightly greater than the sliding speed of the net/cement assembly on band (7).

The roller-carrying frame is connected elastically with a vibrator (16), for instance an electro-magnetical one, carried by an upper supporting frame.

Moreover, the distance between the edges of the blades and the band (7) is adjustable so that the blades be in contact with or draw in the surface of the slab being formed, so as to be able to hit it and set it into vibration.

The slab under formation receives, thus, mechanical stresses of a high frequency by the revolving blades, without however their causing any stoppage of the movement of the slab itself. The compacting device may be achieved also with rigid vertival elements having at their ends sliding elements such as, for instance, idling rollers, spheres, small plates oriented in the sense of motion of the nets, etc.. Or it may be achieved by rows of rotating elements turning in the sense of the net-like structure, for instance wheels, and prompted by the vibrations, to hit rapidly the surface of the nets and of the cement mix.

The vibratory motion which acts vertically, may be obtained,according to known methods, by means of electro--mechanical or pneumatic apparatuses, while the frequency of the vibrations, depending on the speed of the motion of the nets, on the type of nets and on the matrix and the thicknessof the slab, may vary within a very wide range, that is, from just a few cycles/second to several hundred cycles/second.

Compressor (f') may consist of a pair of rollers of which, for instance, the lower one is driven by a motor, and between which it is possible to carry out a distance adjustment and to pass the composite slab onto the conveyor belt; or it may consist of a doctor blade system with a smoothenning and thickness-regulating blade.

In order to avoid the adherence or dragging of the cement and/or of the net by the rollers, these latter may be covered or coated with anti-adhesive sunstances, for instance silicon resins, and they may, moreover, be fitted with scraping blades or with nozzles for air jets, in order to favour the detachment (separation) of the slab.

Before and/or after compressor (f') there may be present, in a succession, suction systems for the removal of the excess of water present in the slab.

In figure I is represented in a side view (A) and in a plan view (B), an operational unit of the device of this invention, with the accessory elements suited for its working. In said figure there will be noted:
A feeding device (1) for the feeding of the net-like structure (2); the net-guide (3) (which may be a roller or a rotating brush) which serves to approach said net-like structure to the porous surface (7)in motion in the sense in which the arrow points; the porous surface supporting the

drilled plate (9); the dosing devices (4), fed by volumetric pump (5) through valves (6); a vibrator (8); a compressor (10) consisting of rollers (19) and (20), of which roller (20) is driven by a motor (13); gaskets (17), placed longitudinally on the porous surface, for retaining the cement mix spread on said surface, and for avoiding losses of the mix following lateral spilling of the mix itself.

In fig. I, (C) represents a doctor-blade compression system, with blade (21) for the scraping and regulation of the thickness of the cement slab.

In fig. II there is represented a type of device according to this invention, consisting of three operational units arranged in series, where, additionally, there are represented: the suction systems (14) placed under the vibrators (8); a further suction system (11); a conveyor belt (18) for gathering the final plate or slab; a washing device (12) for the porous carrying surface; rotating blades (19) for the trimming of the slab and the moving cutting lance (20) for the cutting of the slab into crop-ends.

Still in figure II, (B) represents a schematical view of the production steps for a composite slab consisting of three nets (2) alternated with three layers of cement mixes (21).

Referring to fig. I, the carrying out of the operations in the process of preparation through an operational unit, is the following one:
The net-like structure (2) is unwound from the reel by means of the unwinder (1), guided by the net-guiding system (3) on the porous band (7) moving horizontally, and is placed on the cement layer pre-existing on the said conveyor belt, where it will be covered up with a layer of cement coming from the successive doser (4). The assembly of cement/net/ /cement is then conveyed to the vibrator-compacter (8), then to the compression or lamination system (10) and from there it is conveyed towards the successive operational unit, where it suffers the superimposition of a new net-like structure followed by that of another layer of cement.

Passing from one operational unit to the successive one, in a device consisting of various different operational units arranged in series, like the one represented in fig.II, the single laminated elements are superimposed naturally on one another, they combine with each other and compact themselves forming the final humid slab which comes out of the last pressing position.

In order to obtain a good union or joint of the single elementary layer with each other, it is however necessary that the percentage of residual water in each layer and the state of compacteness be such as to allow the diffused filtration of the successive overlying layers. Thus, the pressurees in the compressor (10) (and the possible suction in the suction systems (14)), will have gradually growing values, growing from the first to the last operational unit and will have to be adjusted (regulated) in such a way that the residual water in each intermediate layer be comprised, as a general indication, to be verified for each type of plant and each cement/nets composition, within about 0.25 to 0.35 of the water/solids relationship.

In the last operational unit, the final composite slab, after compacting of the last cement/net layer, is preferably subjected to a vacuum phase with the purpose of removing the water in excess with respect to the final level of water/solid relationship of about 0.20-0.25, wherein the slab displays sufficient consistency for the successive processing stages.

The removal of the excess of water may also be obtained in the course of the last compression or lamination phase in the last operational unit which, having to bring the slab to the finally desided thickness, necessarily cre

ates a considerable superficial pressure and increases the contact between the reinforcement and the matrix, eliminating the water in excess or possible air bubbles.

The process according to this invention permits also to produce slabs with different profiles, undualted etc., either by the known undulation or profiling systems on the trimmed and cut slabs, both by the use of a porous surface already having the desired profile, for instance an undulated profile, and of all the organs of the machine and in particular the net-guides, the compactors, the vacuum boxes, the compression or pressure rollers, as well as all the motion, transmission and belt-cleaning rollers having the same profile of the belt itself, so as to maintain the necessary adherence.

EXAMPLE 1 :

Using a device, consisting of 5 operational units arranged in series, each of the type illustrated in fig. I, there were produced flat slabs of cement reinforced with about 8% by volume of net, obtained from a fibrilled polypropylene film.

The slabs showed a finished size after trimming, of: 100 x 200 cm and 7 mm thickness.

The rough width, before trimming amounted to 106 cm. The net of polypropylene showed a weight of 107 g/cc, had open meshes and was 106 cm wide, being formed of 12 layers of polypropylene films each 75 micron thick, fibrilled by longitudinal slitting and subsequently spread open transversally with a 9-fold expansion of its original width, wherefore it suffered a longitudinal shrinkage or contraction of 0.85.

The layers in the net showed the unfibrilled slanting bands arranged approximately at ± 12° and ±25° with respect to the direction or sense of the slitting or fibrillation.

The preparation of the slabs was carried out by sucessively impregnating with a cement mix 5 nets whose total weight amounted to 535 g/linear meter.

The cement mix was of the following composition:

- Portland 325 cement = 100 parts b.w.
- water = 39 parts b.w.
- superfluidizing agent at 20% concentration= 1 part b.w.

The density of the mix was equal to 1.90 g/cu.cm

The feeding rate of each of the five nets, and the speed of the porous surface, were both 12 mt/minute.

The peripheric (peripheral) speed of the rollers forming the

compressor (10), is greater by about 2% than the speed of the porous surface, so as to maintain the slab always in traction (tension).

The dosing of the mix, by means of the volumetric pumps, is adjusted in each operational unit as follows:

1st operational unit: 23.0 lt/min. of which:
- 13 lt/min. to the dosing device before the deposition of the net;
- 10 lt/min. to the dosing device after the deposition of the net.

2nd, 3rd & 4th unit, respectively : 21.0 lt/min. of which:
- 10.0 lt/min. to each dosing device before deposition of the net;
- 11.0 Lt/min. to each dosing device after the deposition of the net.

5th op. unit : 24.0 lt/min. of which:
- 10.0 lt/min. to the dosing device before deposition of the net;
- 14.0 lt/min. to the dosing device after deposition of the net.

for a total of: 110 lt/min.

The porous surface (or conveyor belt) consisted of a felt of polypropylene fibres, needle-point treated, with a specific weight of 1500 g/sq.mt.

The elimination of the excess water in each unit was regulated as follows:

- in the first units from 1 to 4 = free discharge,
- in the 5th unit: = 350 mmHg of vacuum applied immediately after the 5th compacting device.

The compression rollers were regulated as follows:

		Pressure between rollers (Kg/sq.cm)	Max. distance between rollers
1st	unit =	10	2 mm
2nd	unit =	10	4 mm
3rd	unit =	15	6 mm
4th	unit =	20	8 mm
5th	unit =	35-45	7 mm

The compacting system consisted of a frame carrying 4 (four) rollers, each carrying 32 blades, and having a diameter of 120 mm, said compacting system being operated by an electromagnetic vibrator producing vertically directed vibration,

at a frequency of 3000 cycles/minute.

The slab at the outlet of the last compression position showed a content in water, measured by drying in an oven at 105° ÷ 110°C, of 22.7% on the total weight of solids.

The slabs were trimmed at the edges to 100 cm width and then cut to a length of 200 cm.

After staying of the slabs in water for 28 days and ensuing dry ing in the air for 48 hours, there were measured the unitary resistances at break under bending stresses, by method UNI 3948, thereby obtaining the following results:

- Resistance, in longitudinal direction = 388 Kg/sq.cm
- Resistance in a transversal direction = 137 Kg/sq.cm

The thickness of the sample slab amounted to 6.9 mm, as the mean value of 10 measurements at different points.

EXAMPLE 2 :

With the same machine of the preceding example, with the same type of polypropylene nets and with the same procedures of combination, there were prepared slabs of the following net size: 100 x 200 cm x 7 mm of thickness, using white cement coloured with mineral pigments:

The cement mix was of the general composition:

- white Portland (cement, type 425: 100 parts b.w.
- water 39 " " "
- superfluidizing agent at 20% concentr.: 1 " " "

The dosing or metering device n°1 and n°10, which give place to the formation of the two outside (external) layers of the finished slab, were fed with the above indicated mix additioned with 3.5% b.w. of red iron oxide, while the intermediate metering devices were fed with the general mix.

The process conditions were the sare as those used in example 1.

After staying in water and drying in the air, the slabs which on the surface showed a uniform light red tinge, were measured as to their bending resistance with UNI 3948 method, obtaining the following results:

- longitudinal resistance	=	396 Kg/sq.cm
- transversal resistance	=	153 Kg/sq.cm
- thickness, mean value on 10 measurements	=	7.0 mm

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C L A I M S

1) Process for the continuous production of slabs, panels and other like manufactured articles, based on water-settable binders, and containing incorporated in them net-like structures made of synthetic polymers as reinforcements, characterized in that said process comprises at least one full series of the following operations, from (a) to (f), carried out in a continuous way:

(a) deposition of one layer of a cement mix on a band or conveyor belt, or a porous surface in a horizontal motion;

(b) feeding of an open-mesh, net-like structure consisting of a fibrilled film or of a plurality of superimposed fibrilled films, onto said layer, in the direction and sense in which said band or porous surface is moving;

(c) deposition of the net-like structure on the surface of said layer;

(d) deposition of one layer of cement mix on said net-like structure;

(e) compacting of the whole assembly consisting of layers of cement mix and of the net-like structure, by vibrations carried out in an at least vertical sense;

(f) compression of said assembly or whole, with the consequential reduction of its content in water to values comprised between 25% and 35% on the weight of the solids present.

2) Process according to claim 1, characterized in that the compacting operation (e) is carried out with a simultaneous downward percussion of the nets enbedded in the cement.

3) Process according to claim 1, in which the compression operation (f) is preceded and/or followed by a dehydration phase of the whole or slab, by sucking off the water under vacuum.

4) Device for regulating the process according to the preceding claims, characterized in that said process comprises one or more operational units, arranged in series, each one consisting of:

(a') a feeder of net-like structures with open meshes, consisting of one or more superimposed fibrilled films;

(b') a horizontal porous surface in motion;

(c') a device for the guiding of the net-like structure on said prorous surface;

(d') at least one feeding-dosing device for the deposition of the cement mix on said surface or on said net-like structure;

(e') a vibrator, vibrating at least in the vertical sense for the compacting of the cement mix;

(f') a compressor for the compressing of the cement mix.

5) Device according to claim 4, characterized in that it comprises suction devices placed before and/or after the compressor (f').

6) Device according to claim 4, characterized in that the vibrator (e') comprises rotating rollers provided with radially arranged reliefs which are in contact with, or draw in the surface of the slab.

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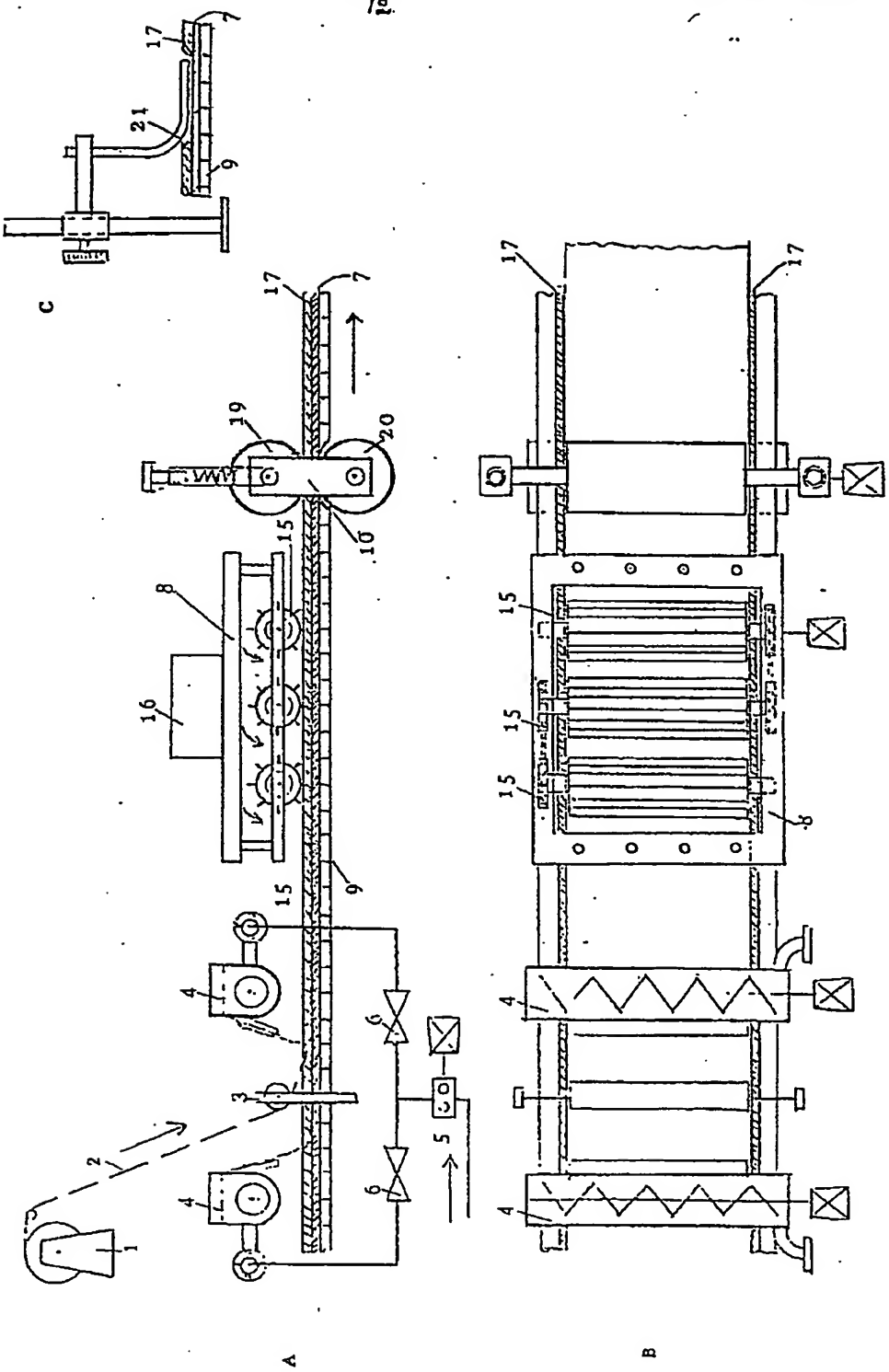

FIG. I

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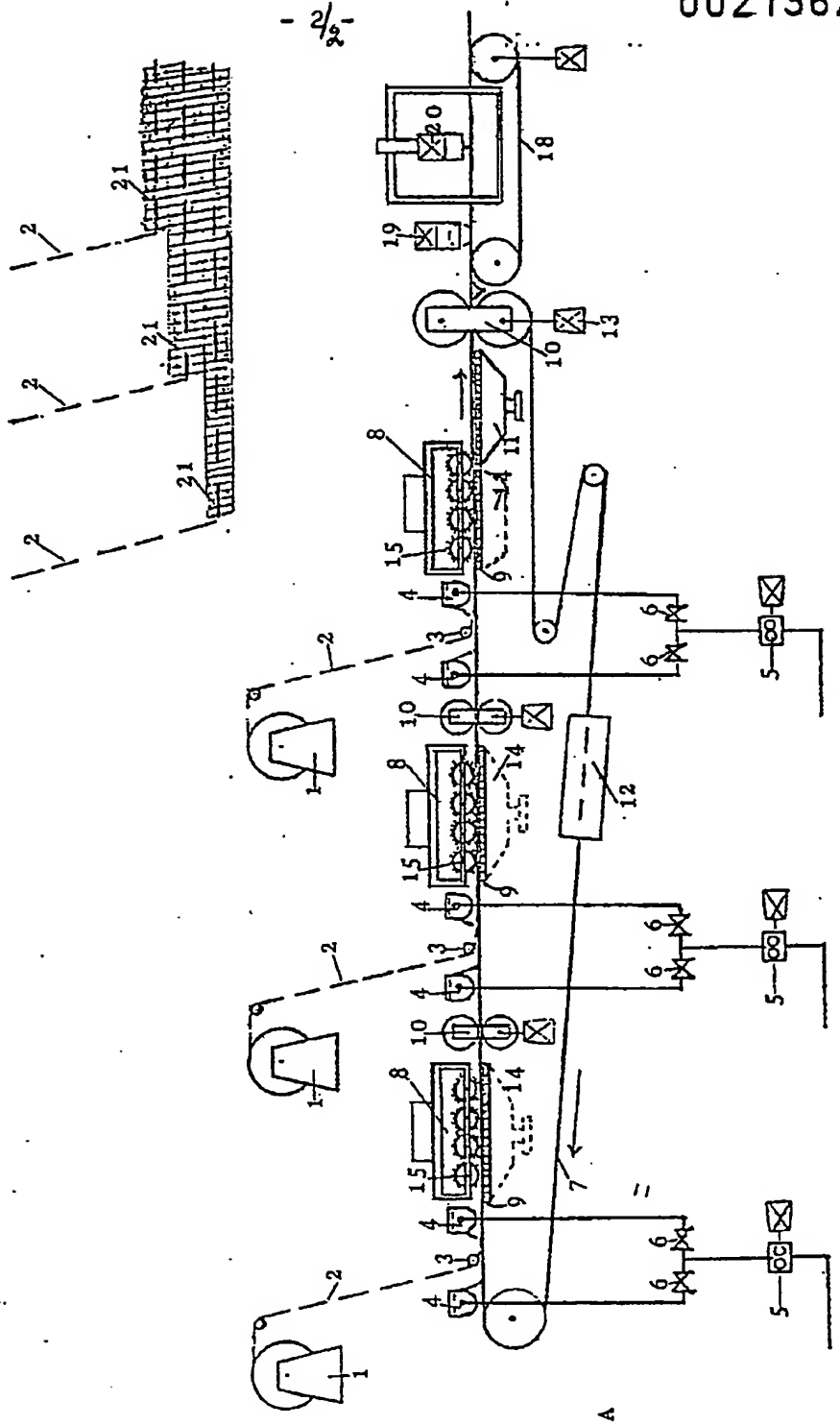

European Patent Office

EUROPEAN SEARCH REPORT

Application number EP 80 10 3450

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
E	GB - A - 2 038 701 (STAMICARBON) * Page 4, lines 3-39; figure * & NL - A - 79 08211 & BE - A - 880 149 & FR - A - 2 442 115 & DE - A - 2 946 225	1,3-5
	FR - A - 2 356 610 (UNIVERSITY OF SURREY, HANNANT) * Page 3, lines 28-32; page 5, lines 10-16; page 8, lines 17-24 *	1,3-5
E	EP - A - 0 003 245 (STAMICARBON) * Page 11, line 14 - page 12, line 28; figure 1 *	1,3-5
	FR - A - 923 935 (J.R. DERLON) * Whole document *	1,4
	FR - A - 905 006 (J.C. THOREL) * Page 3, lines 9-40; figure 7 *	1,4
E	GB - A - 2 034 627 (DOW-MAC CONCRETE) * Whole document *	1,3-5

CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)

B 28 B 23/02

TECHNICAL FIELDS SEARCHED (Int.Cl.³)

B 28 B
C 04 B
E 04 C

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	18-09-1980	BOLLEN

EPO Form 1503.1 06.78